

CLINICAL

THERMOMETERS AND THERMOGRAPHY.

Edward Seguin

CONSIDERING that clinical thermometry was hardly spoken of in this country before 1867, and that it was first introduced in a half dozen of our hospitals during that year, it speaks well for the quickness of mind of the American practitioners, and for the energy of the American manufacturers of philosophical instruments, to see clinical thermometers wherever physic is practised, and to read about thermometry and thermography in all the medical publications. Indeed, in the past eight years, it has become more impossible to practise physic without a thermometer than it was before without a lancet.

Carried by the same movement, American women—who always want to learn what is good for them to know—seeing the diagnostic power physicians derive from thermometric indications, have begun to learn the simple rules by which the thermometer indicates the differences between fatigue and fever, uneasiness and prodromic temperatures, the cases manageable by simple nursing from those which require a prompt medical intervention (in *Manual of Thermometry for Mothers*, etc., by Edward Seguin, M.D., at G. P. Putnam's Sons); and now, in well posted circles, the mother takes the temperature of her sick before calling the physician, and later, between his visits; so that he can by her know even what he has not seen.

Other classes are equally interested in the findings of human thermometry: the managers of schools, of asylums, of insurance companies; the chiefs of large industrial, military, and naval establishments, etc. But, to restrict our remarks to the two classes first named, the physicians and the mothers, we must say that their patronage alone creates an immense demand, which must be met by the largest production of the best instruments. Unlike most of the European countries, where the people at large are poor and unalphabetic, the American people breeds no inferior classes and receives an unequalled average education, which enables all not only to read the weather-thermometer, but to comprehend human thermometry.

T. C. Thompson

But, to become the compass of physicians and the guide of mothers, thermometry requires accurate instruments. Otherwise a single error of a half degree may endanger life, a series of errors of a tenth of a degree may falsify a diagnosis, the miss of a rise or fall consequent to a dose may cause its fatal repetition, etc. Indeed, every sickly temperature having a meaning, every thermometric operation having its importance, every instrument must be trustworthy; every good thermometer increases the usefulness of thermometry, and every bad one imperils—with the lives of patients—the very art it pretends to serve.

The manufacture of thousands of equally accurate, therefore concordant, thermometers is an actual problem, but one not so easily solved as it may seem to an outsider, because skill alone does not suffice to make them perfect; another element—time—enters into their composition. When skilfully made, time must be allowed to their materials to harmonize. The glass tube shrinks, the mercury moves, causing relative displacements of several degrees during the six first months, of several tenths of a degree during eighteen or twenty months more. Therefore, the best *makers* cannot *make* good thermometers unless they put off their graduation at least two years. After this lapse of time between the *making* of the instruments and the *marking* of their scale, it is to be expected that, from the central point of health, 98.6° Fahrenheit, equal to 37° Centigrade, equal to 0 of the physiological scale, up to 45° C., and below to 33° C., there will be no deviation larger than the twentieth of a degree from the metrical *étalon* (standard measure) deposited at the Smithsonian Institute. Such deviations are met with in the very best instruments, whose makers take pride in having these infinitesimal errors consigned in a certificate from the Kew Observatory, where their instruments are tested on the *étalon*.

Till a similar measure of verification be adopted in this country, it becomes not only a question of good workmanship, but of good faith, to produce thermometers equal to those of England. If we do, an official control is unnecessary, an immense patronage will be our reward, and a large share in the next progress of physic will be our honor.

On the perfection of the instruments the manufacturer has much influence; on the choice of a thermometric scale hardly any. This choice is generally determined by tradition, example, habit, sooner than by a sound criticism. What the manufacturer can do is to produce them all, and to throw them all in the market, with hardly an intimation as to their defects, or adaptability to the wants of the clinic, and of the divers systems of thermography.

1st. The scale of Reaumur, though yet of great authority in physics, and employed in medicine by some distinguished men, can be here but a cause of trouble and of obscurity of the problems of clinical thermometry.

2d. The Fahrenheit scale is generally used in this country as in England, though many physicians of good standing object to it, because: *a.* Its figures have no common divisor with the other measures of the body and its symptoms. *b.* Its central figure, O, is 98.6° distant from the central point of the drama of life and death, a distance which precludes any mathematical reckoning thereof. *c.* It requires the constant reference to tables of equivalents when its findings have to be compared with those of other scales.

3d. The Centigrade scale is used by many nations as part of a uniform reckoning (the metric system) which offers a common divisor for all the pathological quantities mathematically appreciable. The only objection to its use in medical records is that its central figure, O, is 37° distant from the health point, wherefrom must start all the calculations upon the course of diseases, the effects of medication, food, etc. However, this difficulty is avoided by displacing the O of the Centigrade scale from the point of melting snow to that of human health, without altering its Centigrade divisions in degrees.

PHYSIOLOGICAL THERMOMETER.



4th. This modification constitutes the *Physiological Scale*, whose figures are calculable in all proportions with those of any other pathological quantities worth recording, and by mentally adding thirty-seven to the findings. The physiological scale may be, like the others, reproduced by *curves* (see graphic tables, p. 5), and is the only one whose *figures* can be mathematically treated (see mathematic tables of vital signs, p. 4).

The self-registering thermometer is the only one which needs to be prepared for insertion by gentle swings of the arm or shakes of the hand, to put the index down below the point at which the body-temperature is expected to raise it again. Otherwise the less movement the best; some persons have to break or spoil a few thermometers to understand this.

Before applying the fever-thermometer, it saves time to warm it to about ten degrees less than the norme, and to dry the axilla if moist. The insertion takes place by putting the instrument half-way under the fold which marks the junction of the chest and arm, and crossing the former on the latter for about seven minutes, or till the mercury is seen to rise no more.

**MATHEMATICAL RECORD OF USTION, CIRCULATION, AND RESPIRATION,
TAKEN WITH THE PHYSIOLOGICAL THERMOMETER.**

No. of instrument,	Name,	Age,	Sex,	Malady,	No. of Septenary,
Date,					Maximum day.....
Day of sickness,					Minimum day.....
Barometry,					Difference.....
External thermometry,					Sum of morning.....
					Sum of evening.....
Time of observation,					Sums of the week.....
{ Central temp. taken in }	{ Fever.....				" of fevers.....
	{ Norme, 98.6° F. = 37° C. = 0.				" of normes.....
	{ Depression.....				" of depressions.....
	{ Daily average.....				" of averages.....
	{ Daily excursus.....				" of excursus.....
{ Local temp. taken on }	{ Sick point.....				" at sick point.....
	{ Healthy point.....				" at healthy point.....
	{ Difference.....				" of difference.....
Normal pulse.....	sickly.				" of sickly pulse.....
Pulse, daily excursus.....					" of pulse excursus.....
Norm. respiration.....	sickly.				" of sickly respiration.....
Respirat. daily excursus.....					" of resp. excursus.....

GRAPHIC RECORD OF VITAL SIGNS.

DATE,

NAME,

DISEASE,

REMARKS.

DAYS OF
DISEASE.

TEMPERATURE. (FAHRENHEIT'S SCALE.)

110°

109°

108°

107°

106°

105°

104°

103°

102°

101°

100°

99°

98°

97°

96°

95°

PULSE-BEATS PER MINUTE.

150

140

130

120

110

100

90

80

70

60

RESPIRATIONS PER MINUTE.

50

45

40

35

30

25

20

15

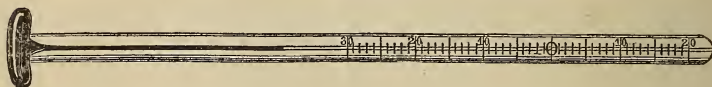
ME ME ME ME ME ME ME ME ME ME ME ME ME ME ME ME ME

The other kinds of thermometers demand the same care. They are included in two classes: one whose varied forms are devised to satisfy artistic tastes, or calculated to diminish the chances of breakage; the other, whose forms or different philosophical principle are intended to fulfil special thermic indications.

The first category needs no illustration, bearing names generally sufficiently descriptive: the *curved*, the *pencil case*, the *screw case*, etc., or the name of their inventor.

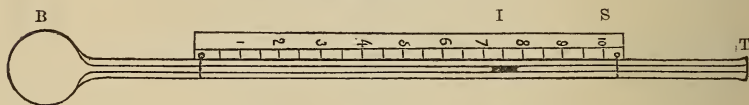
The second category contains the instruments whose form or philosophical principle permit to measure body-temperatures which the fever-thermometer cannot well reach, nor correctly express; the principal ones are the surface-thermometer of Winternitz of Vienna, which has not been yet executed in this country.

THE SURFACE THERMOMETER.



In the *surface* thermometer the *form* alone is interesting, as calculated to meet (by light adaptation) almost any part of the periphery whose combustion and frigeration have to be observed. This is done simultaneously with two surface thermometers, or with one successively applied on a sick and on a healthy corresponding point, and the results are recorded as seen on the mathematical chart, page 4.

THE THERMOSCOPE.



It is its principle which—old in physics—has but recently been applied to medical observation. Taking advantage of the sensitiveness of air to heat and cold, the air contained in the *reservoir B* is *corked up* by a drop of water *I*, which, moving, in the tube *T* as the air in the bulb is dilated or contracted, progresses along the scale *S* placed outside.

To make the thermoscope ready for clinical or maternal use, its bulb is heated over a lamp or fire, sooner in a bowl of hot water, and when the air contained in the bulb is dilated a few degrees above the ambient temperature, the open end is quickly plunged in—an inch deep—and quickly withdrawn from

another bowl of cold water. The drop or two which will have then entered the mouth, is seen to run up the tube. If it stops near the bulb, it will be the index of the thermoscope; if it stops sooner, say two or three inches from the mouth, or if it runs into the bulb, the latter was too cold or too hot; we have to jerk away that drop of water and recommence; three or four trials to obtain a good water-index take hardly a minute.

In this condition, the air contained behind the water-index makes itself isothermal to the ambient temperature, and the thermoscope is ready.

Simpler yet: Overheat the bulb, let the water run in it. When you want an index, invert the instrument, apply your hand on top; some water will descend in the tube and form an index; then quick, fit your scale to it, look at your watch, all is ready.

When the external heat is near blood-heat, the air in the bulb having become isothermal to the former cannot be much dilated by the contact of fever-heat; therefore the *index* will *indicate* nothing. But in this circumstance, the bulb being previously plunged in cold water, the index will soon be incompressible again. For mathematical observations the temperature of the cold water so used is taken, and serves as starting-point of the excursus, just as that of the ambient air serves in ordinary conditions when exactitude is desirable; any weather-thermometer is good to establish this comparison.

The thermoscope is applied anywhere an anomaly of calorificity is known or suspected. Its habitual place (*lieu d'élection*) is not, however, the axilla; it is the shut-hand. In ten to fifteen seconds the index has attained the maximum height or fall of any significance. To read it, we mark the starting-point of the index, the terminus of its course, and the time (in seconds) to reach it. To take more mathematical observations, a mobile scale is attached to the stem, and made to slide, in order to put its lowest figure on a level with the head of the water-index, or the converse to take frigid temperatures; so that a thermoscope is always correct—that is more than can be said of most of our clinical thermometers.

But with or without a scale, it gives, by contact, indications, (a) at the start of the volume of heat escaping by radiation, (b) at the end of its course, of the *portée* or reach of its velocity; whilst, without contact, by gently blowing on the bulb, it shows the degree of combustion which takes place in the lungs, and other phenomena of uction too long to explain here.

Without a scale a mother can tell at what hour the index rose quicker and higher, or quicker only, and not so high, etc. Without a scale, too, a physician who well knows his case, and is short of time, can, in less than ten seconds, decide upon the dynamic conditions of the next twelve or twenty-four hours



dependent on the waste of caloricity by radiation—that is to say of life itself in many cases—and prescribe accordingly.

The thermoscope may often be called to decide about the precise seat of an affection indicated only by general, reflex and regional symptoms. Prof. Sayre informs me that in a case of sacro-iliac disease, so obscure that all other means of diagnosis had failed, the thermoscope indicated the place of lesion. (J. S. Green, in *New York Medical Journal*, Dec., 1875, p. 615.) It criticises and explains these enigmatic temperatures which ostensibly remain near the norme after a deadly accident, or otherwise appear before death; and which, made up of a high fever and shock or hemorrhage, are *compound temperatures* whose composition cannot be analyzed by the ordinary thermometer, but is found out by the more sensitive thermoscope.

Passing from the sick-chamber to the dead-house, the thermoscope proves to be the only *necrometer* founded upon the law of radiation, as per example:—Being applied below the sternum of a body brought three hours previously to the dead-house of the Bellevue Hospital, the index did not move from the position it had taken in the ambient temperature of a very cold January day, but put in the axilla it slowly and steadily rose 6 centimetres = 2 inches; there was yet vital heat, though a thermometer inserted instead of the thermoscope failed to demonstrate any.

So the thermoscope, in contact with the living, shows the activity of their caloricity; and, in contact with the dead, ceases to indicate heat only when and where organic combustion becomes progressively extinct. As thousands are and have been buried alive, the invention of a true *necrometer* excites a deep interest, intensified, if possible, since cremation is mooted. For some have knocked at their coffins and re-entered the world; but of what use would it be to knock for help inside of the furnace? The proof of death is wanted now more than ever; the thermoscope gives this proof alike to the savant and to the ignorant.

No family, and certainly no physician, must be without it. Few persons are without a weather-thermometer, but how many possess the instruments which bring home the knowledge of these internal temperatures which are warnings of imperilled life? So, let the gardener watch the zero of external temperature which will kill his cucumbers, but let the physician warn the mother of the significance of the zero of the physiological thermometer for the security of her children.

(See *Medical Thermometry and Human Temperature*, by E. Seguin, 2d ed., pp. 430, W. Wood & Co., publishers, 27 Great Jones Street, New York.)